

CONNECTICUT RIVER FLOOD CONTROL PROJECT

HARTFORD, CONN.

CONNECTICUT RIVER, CONNECTICUT

SPECIFICATIONS

FOR THE FURNISHING OF

KEENEY LANE PUMPING STATION EQUIPMENT

ITEM Ht. 11 - CONTRACT



**WAR DEPARTMENT, CORPS OF ENGINEERS, U. S. ARMY
U. S. ENGINEER OFFICE, PROVIDENCE, RHODE ISLAND**

JANUARY 1947

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BOSTON, MASS.

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SPECIFICATIONS

PART I

STATEMENT OF WORK

SW-1. DESCRIPTION OF WORK. - a. Work to be done. - The work consists of furnishing all plant, labor, and materials, and performing all work, design, manufacture, and delivery, f.c.b. railroad cars at Hartford, Connecticut, or f.o.b. trucks at the project site, of equipment for the pumping station, in strict accordance with these specifications and schedules and drawings forming parts thereof for KEENEY LANE PUMPING STATION EQUIPMENT, HARTFORD, CONNECTICUT.

b. Location. - The site of the work is in the City of Hartford, Connecticut.

c. Appropriation. 21X3113 - FLOOD CONTROL, GENERAL.

d. Authority. - The work provided for herein is authorized by the Flood Control Act of 28 June 1938 (Public No. 761, 75th Congress, 3rd Session) as modified by the Flood Control Act of 18 August 1941 (Public No. 228, 77th Congress, 1st Session) and the Flood Control Act of 22 December 1944 (Public No. 534, 78th Congress, 2nd Session).

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PART II

GENERAL CONDITIONS

GC-1. SCOPE OF WORK. - The work to be performed under this contract consists of furnishing all plant, labor and materials, and performing all work required by Article I of the contract, in strict accordance with the specifications and drawings, all of which are made a part hereof. The equipment furnished shall be complete, with all parts in good working order, of good material, and with accurate workmanship, skillfully fitted, and properly connected and put together. All work, materials, and services not expressly called for in the specifications or shown on the drawings, but which are necessary for complete and proper operation of the equipment, shall be performed and furnished by the Contractor at no increase in cost to the Government.

GC-2. PROTECTION OF MATERIALS AND WORK. - The Contractor shall at all times take care to protect and preserve all materials, supplies and equipment of every description (including property which may be Government-furnished or owned) and all work performed. All reasonable requests of the Contracting Officer to enclose or specially protect such property shall be complied with. If, as determined by the Contracting Officer, materials, equipment, supplies and work performed are not adequately protected by the Contractor, such property may be protected by the Government and the cost thereof may be charged to the Contractor or deducted from any payments due to him. Any machinery, materials, and articles in complete or incomplete state, for which partial or complete payment has been made prior to delivery, shall be adequately protected by the Contractor from loss and from corrosion and any and all other forms of damage.

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PART III

SPECIAL CONDITIONS

SC-1. COMMENCEMENT, PROSECUTION AND COMPLETION. - a. The Contractor will be required to commence work under this contract within fifteen (15) calendar days after the date of receipt by him of notice to proceed, to prosecute said work with faithfulness and energy, and to deliver the entire work ready for use f.o.b. railroad cars at Hartford, Connecticut or f.o.b. trucks at the project site not later than four hundred and fifty (450) calendar days after the date of receipt by him of notice to proceed.

b. Other agencies will unload the equipment from the carrier at Hartford, Connecticut, transport it to the site, and install it. Metal items to be embedded in the concrete, together with the necessary templates, shall be shipped in advance of the delivery of the equipment on the work, as directed by the Contracting Officer.

SC-2. QUANTITIES. - Within the limit of available funds the Contractor will be required to complete the work specified herein in accordance with the contract and at the contract price or prices.

<u>Item No.</u>	<u>Quantities</u>	<u>Unit</u>	<u>Description of Item</u>
1	3	each	36-Inch Pump and Piping
2	1	each	16-Inch Pump and Piping
3	3	each	Gasoline Engine
4	3	each	Right-Angle Gear Unit for 36-Inch Pump
5	1	each	Right-Angle Gear Unit for 16-Inch Pump
6	1	each	Diesel Engine

SC-3. PAYMENTS. - a. Eighty (80) per cent of the applicable unit or lump sum price will be paid upon delivery of each piece of equipment at Hartford, Connecticut, and receipt of all required drawings pertaining to such equipment, together with properly executed invoices.

b. When the terms of the contract have been fully complied with, and all the equipment has been installed, tested, and accepted by the Contracting Officer, final payment will be made of the balance due under the contract.

c. In the event that field tests and trials have not been made within one year after the delivery time specified in the contract or within one year after the actual delivery date, whichever is later, the Contractor shall receive final payment. The performance bond will be kept in effect until such time as conditions permit the final testing and acceptance of the equipment.

d. Unless otherwise authorized in writing by the Contracting Officer, the items of work for which payment will be made shall be limited to those listed and enumerated in the contract. The unit prices or lump sum price or prices stated in the contract will be used in determining the amount to be paid and shall constitute full and final compensation for all the work.

SC-4. CONTRACT DRAWINGS, MAPS AND SPECIFICATIONS. - a. The work shall conform to the following contract drawings and maps, all of which form a part of these specifications and are available in the U. S. Engineer Office, 31 St. James Avenue, Boston 16, Mass.:

LIST OF DRAWINGS

<u>Sheet No.</u>	<u>Title</u>	<u>File No.</u>
1	General Arrangement No. 1	CT-4-3296
2	General Arrangement No. 2	CT-4-3297
3	General Arrangement No. 3	CT-4-3298
4	General Arrangement No. 4	CT-4-3299

b. Ten (10) sets of contract drawings, maps and specifications will be furnished the Contractor without charge. Additional drawings will be furnished on request at the cost of reproduction.

SC-5. DRAWINGS REQUIRED OF CONTRACTOR. - a. Detail drawings. - Within 30 calendar days after the date of receipt by him of notice to proceed, the Contractor shall submit to the Contracting Officer for approval, assembly and detail drawings in duplicate to demonstrate fully that the equipment to be furnished under the contract will conform to the provisions and intent of these specifications. In the event that the Contracting Officer shall find that the drawings as submitted by the Contractor are in accord with acceptable practice and meet the requirements of the specifications, the Contracting Officer will return one set of said drawings with his approval; otherwise, said drawings will be returned to the Contractor with a statement of the points wherein they have been found unsatisfactory, in which case the Contractor shall proceed at once to revise said drawings until they have been found satisfactory by the Contracting Officer and are approved by him. After approval, the Contractor shall furnish the Contracting Officer six prints of each approved drawing. Each print submitted for approval shall have, in the lower right-hand corner just above the title, a white space 3 inches by 4 inches in which the Contracting Officer can indicate the action taken. All of these drawings shall form a part of the contract but approval of drawings by the Contracting Officer shall not relieve the Contractor of full responsibility for the correct fitting of parts and satisfactory assembly. The Contractor shall furnish, in sextuplicate, complete instructions for the proper operation and maintenance of the equipment including the proper lubricants to be used, based on the fact that the equipment is not intended for constant and frequent use.

b. Erection drawings. - Before delivery of the equipment, the Contractor shall furnish the Contracting Officer six prints of erection drawings indicating the relationship of all match marks painted or stamped on the several parts.

SC-6. PACKING AND SHIPPING. - a. All parts likely to be lost or damaged in shipment shall be adequately boxed, or crated, and each box or crate shall be marked to show the parts contained therein. All exposed finished surfaces on large parts shall have wooden pads bolted on, or shall be otherwise properly protected. The Contractor shall provide all lumber, bolts, etc., necessary for proper protection.

b. As soon as each shipment is made, the Contractor shall furnish to the Contracting Officer shipping notices on which shall be shown, in addition to the usual data, a description of the article furnished and the item number of the contract schedule to which the article applies; also the shipping weight of each item.

SC-7. MARKING. - All parts of the equipment shall be marked and match marked for identification and to facilitate field assembly.

SC-8. WEIGHING. - The Contractor shall weigh all completed parts and accessories on accurate scales, and the complete list of all such net weights, exclusive of boxes, crates, or skids, shall be furnished the Contracting Officer. The net weight of each of the larger pieces shall also be painted on the piece or stated on a tag securely attached thereto.

SC-9. MANUFACTURER'S NAME PLATE. - The Contractor shall attach a small brass name plate on the principal parts of each unit, giving the manufacturer's name and address, serial number and the principal rating data of the equipment.

SC-10. INSPECTION. - The work will be inspected in accordance with Article 4 of the contract by inspectors appointed by the Contracting Officer. The inspectors will make a rigid inspection of all materials and work done, and any material or workmanship found to be defective or not in accordance with the drawings and specifications will be rejected and shall be replaced by satisfactory material or workmanship without charge to the Government. The presence of the inspector will not relieve the Contractor of any responsibility for the proper execution of the work. The acceptance of any material or finished member by an inspector shall not prevent subsequent rejection if such material or member is later found to be defective.

SC-11. STANDARD TEST AND QUALITY. - a. All materials, supplies, and parts and assemblies thereof, entering into the equipment to be furnished under these specifications, shall be tested, as specified or otherwise required, in conformity with the best modern approved methods for the particular type and class of work. Four copies of material test reports shall be furnished to the Contracting Officer by the Contractor.

b. Unless waived in writing by the Contracting Officer, all tests and trials shall be made in the presence of an inspector appointed by the Contracting Officer. When the presence of the inspector is so waived, sworn statements, in quadruplicate, of the tests made and the results thereof, shall be furnished to the Contracting Officer by the Contractor.

c. The costs of all shop tests and trials shall be borne by the Contractor and shall be included in the contract price.

d. All materials, parts, and equipment shall be of the highest grade, free from defects and imperfections, of recent manufacture, and unused. Workmanship shall be of the highest grade and in accordance with the best modern standard practice.

SC-12. STANDARD STOCK ARTICLES. - All materials, supplies, and articles not manufactured by the Contractor shall be the products of recognized reputable manufacturers. The products of firms other than those specified herein will be accepted when it is proved to the satisfaction of the Contracting Officer that they are equal in strength, durability, usefulness, and convenience for the purpose intended.

SC-13. SERVICE OF ERECTION ENGINEER. - a. The installation of the equipment is not included in this contract, but will be done by other agencies. However, the Contractor shall furnish promptly upon written notice by the Contracting Officer, the services of a competent erection engineer to supervise and direct the erection and installation of this equipment. The services of the erection engineer will be paid for by the Government at an allowance of twenty-five dollars (\$25.00) per calendar day from the time of departure from, to the time of return to, his home station, provided the travel time shall not exceed two calendar days; such allowance to cover salary, travel, and living expenses of the erection engineer and any other costs occasioned by the furnishing of the service. No payment will be made for services of the erection engineer in connection with alterations to any of the equipment occasioned by failure of such equipment to comply with the requirements of the specifications.

b. The erection and installation of the equipment by other agencies shall in no way relieve the Contractor of sole responsibility for the equipment meeting all the requirements of these specifications and fulfilling all the Contractor's guaranties.

c. Upon completion of the installation of the equipment, the Contractor shall submit a written statement to the Contracting Officer certifying that the equipment has been or has not been installed properly.

SC-14. CONTRACTOR'S GUARANTY. - The Contractor shall guarantee all equipment furnished under this contract for a period of one year from the date of final acceptance thereof, against defective materials, design, and workmanship. Upon receipt of notice from the Government of failure of any part of the guaranteed equipment during the guarantee period, the affected part or parts shall be replaced promptly with new parts by and at the expense of the Contractor.

SC-15. RIGHT TO OPERATE EQUIPMENT. - The Government shall have the right to operate any and all apparatus as soon as, and as long as it is in operating condition, whether or not such apparatus has been accepted as complete and satisfactory, except that this shall not be construed to permit operation of any apparatus which may be materially damaged by such operation before any required alterations or repairs have been made. All repairs or alterations required of the Contractor shall be made by the Contractor at such times as directed by the Contracting Officer. The repairs or alterations shall be made in such a manner that will cause the minimum of interruption in the use of the apparatus by the Government.

SC-16. PERFORMANCE BOND. - The Contractor shall furnish a performance bond with good and sufficient surety or sureties acceptable to the Government in connection with the performance of the work under this agreement on U. S. Standard Form No. 25 or U. S. Standard Form No. 25-B. The penal sum of such performance bond will be 50 per cent of the contract price. This bond will be dated as of the same date as the contract and shall be furnished by the Contractor to the Government at the time the contract is executed.

SC-17. LIQUIDATED DAMAGES. - In case of failure on the part of the Contractor to make delivery of the equipment within the time fixed in the contract or any extensions thereof, the Contractor shall pay the Government, as liquidated damages, the sum of twenty-five dollars (\$25.00), per payment item, for each calendar day of delay in making delivery of the equipment.

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PART IV

TECHNICAL PROVISIONS

SECTION I. PUMPS AND PIPING (Items 1 and 2)

TP1-1. WORK INCLUDED. - a. Under Item 1 the Contractor shall furnish three 36-inch vertical, mixed-flow, volute-type pumps. Under Item 2 the Contractor shall furnish one 16-inch vertical, mixed-flow, volute-type pump. The pumps shall be furnished complete with all intermediate shafting, couplings, bearings, inlet and discharge piping, gate valves, and check valves.

b. The 36-inch pumps will be connected through the right angle gear units furnished under Item 4 (see Paragraph TP3-1), to the gasoline engines furnished under Item 3 (see Paragraph TP2-1). The pumps will be installed as shown on the drawings by other agencies.

c. The 16-inch pump will be connected through the right-angle gear unit furnished under Item 5 (see Paragraph TP3-1) to the diesel engine furnished under Item 6 (see Paragraph TP4-1). The pump will be installed as shown on the drawings by other agencies.

TP1-2. DESCRIPTION OF PUMPS. - a. The pumps shall be vertical, mixed-flow pumps of the bottom-suction, horizontal-discharge, volute type, designed for handling sewage and storm water. Pumps of the axial flow type will not be accepted.

b. The pumps shall operate smoothly and quietly, and without excessive vibration or cavitation. All parts shall be so designed and proportioned as to have ample strength, stability, and stiffness. Each pump shall be of late design and a current model, standard with the manufacturer, and shall be the product of a reliable manufacturer who can show at least 5 years of experience in the manufacture of pumps of the type specified and for similar duty.

TP1-3. OPERATING CONDITIONS. - The pumps shall be capable of satisfactory operation, and shall meet all the requirements of these specifications under the following operating conditions:

Minimum low water elevation	7.0 = feet M.S.L.
Elevation of pump room floor	-1.7 $\frac{1}{2}$ = feet M.S.L.
Elevation bottom of suction conduit	-2.0 = feet M.S.L.

TP1-4. CAPACITY. - a. The 36-inch pumps shall each deliver not less than 45,000 g.p.m. at a total head of 5 feet and not less than 25,000 g.p.m. at a total head of 30 feet. The characteristics of each pump shall be such that the power required to operate them between zero head and a total head of 30 feet shall not exceed the rated horsepower of the engine as defined in Paragraph TP2-3 a.

b. The 16-inch pump shall deliver not less than 9,000 g.p.m. at a total head of 5 feet and not less than 3,500 g.p.m. at a total head of 30 feet. The characteristics of the pump shall be such that the power required to operate it between zero head and a total head of 30 feet shall not exceed the rated horsepower of the engine as defined in Paragraph TP4-3.

c. The heads and capacities in subparagraphs a and b above shall be obtained at a constant speed which shall not exceed 400 r.p.m. for the 36-inch pumps and 600 r.p.m. for the 16-inch pump. The specific speed shall be within conservative limits which shall not in any case exceed the maximum for the conditions specified as established by the Hydraulic Institute, in so far as they may apply. The direction of rotation and the location of the intake and discharge shall be as shown on the drawings.

TP1-5. CASINGS. - a. The pump casings shall be of the volute type, made of high-grade cast iron of ample strength to withstand safely all stresses that will be imposed during erection and operation. The casings shall be made tight and tested in the Contractor's shop under a hydrostatic test pressure of 2-1/2 times shut-off head of the pump.

b. Each casing shall be provided with a removable top head that will permit the removal of the impeller from the top of the pump without disturbing the suction or discharge connections. The head may be made solid or in halves and bolted together. The head shall be provided with a concentric shoulder joint where it is bolted to the casing to secure proper alignment. The casing shall be constructed without stationary guide vanes or diffusion vanes.

c. Hand holes shall be provided in each casing and suction nozzle to provide access to both sides of the impeller. The interior surfaces of the covers shall be shaped to continue the contour of the interior of the casing. The hand-hole covers shall be provided with lever handles for hand operation, so that they can be quickly swung open, closed, and bolted.

d. The casing shall be provided with substantial lugs or feet to support the pump firmly on its foundation. Sole plates of steel or cast iron shall be provided. The casing shall also be provided with eye bolts for lifting and tapped holes for drains. The high point of the casing shall be fitted with a vent pipe connection and valve, so that air or gas may be relieved from the main body of the pump. A suitable connection shall be provided for draining the pump when the valves in the suction and discharge lines are closed. Flanges shall be cast solid and shall be faced and drilled to conform to the American Standard for 125-pound pressure. Flanges shall be spot-faced on the back for all bolt holes. The design of the casing shall be heavy and rigid to resist safely, without distortion, the stresses due to impeller thrust and bearing loads.

TP1-6. IMPELLERS. - The impellers shall be of the enclosed, mixed-flow, single-suction type cast in one piece of cast steel, bronze, or of

a special alloy cast iron containing not less than 1-1/2 per cent nickel and having a tensile strength of not less than 40,000 pounds per square inch. The impellers shall be finished all over to a smooth surface and shall be statically and dynamically balanced. The impellers shall be securely locked to the shaft in such a manner that damage to the pump will be prevented, in case the direction of rotation should become reversed. The impellers shall have openings of a sufficient size to pass spheres 6 inches in diameter for the 36-inch pumps and 4 inches in diameter for the 16-inch pump.

TP1-7. WEARING RINGS. - Bronze wearing rings shall be provided both on the impeller and the casing. The rings shall be machined and constructed to minimize the leakage through them and shall be designed for easy removal and replacement. The design and position of the wearing rings shall be such that wedging of solids flowing along with the water will be avoided.

TP1-8. PUMP SHAFTS. - a. Each pump shaft shall be forged of high-grade, open-hearth steel thoroughly annealed and accurately machined to finished dimensions. They shall be of ample size to transmit the loads without whip, vibration, or undue deflection at all speeds from zero to maximum. The first critical speed of the pump rotor, consisting of the shaft, impeller, and couplings, shall be not less than 150 per cent of the normal running speed.

b. The portion of the shaft within the pump coming in contact with water shall be protected by a removable bronze sleeve extending through the stuffing box. This sleeve shall be securely fastened to the shaft so that it will not be loosened by either forward or reverse rotation of the pump. The bronze sleeves shall be properly machined and ground to finished dimensions.

TP1-9. STUFFING BOX AND GLAND. - Leakage along the pump shaft shall be prevented by means of an approved stuffing box and gland, designed to take sufficient packing to insure tight joints without undue pressure on the shaft. The stuffing box shall be provided with a bronze lantern ring to furnish lubrication and seal with grease. The packing gland shall be of bronze of the split type to allow removal without disturbing any other parts of the pump. The gland bolts shall be of the swing type made of bronze with bronze nuts.

TP1-10. BEARINGS. - The pump bearings shall be two in number and shall be of the anti-friction, grease lubricated type. The bearings shall be designed for heavy duty continuous service and shall be of ample capacity to carry the load. Bearings shall be of the radial ball or roller bearing type and each ball bearing shall be provided with at least two rows of balls. The thrust bearing shall be a combined radial and thrust bearing and shall be capable of carrying, without undue stress in any of its parts, the weight of all rotating parts and the maximum unbalanced hydraulic thrust of the pump. The bearings shall be mounted in the main frame and shall be readily removable. The bearings shall be designed to operate under all conditions of operation that may be expected, including the flooding of the pump room, and shall include a reservoir for 24 hours' supply of lubricant.

TP1-11. INTERMEDIATE SHAFTS. - a. The intermediate shafts for connecting the right angle reduction gears to the pumps shall be made in two sections. The lower section shall be of sufficient length to permit complete disassembling of the rotating element without disturbing the pump casing or the reduction gear. The coupling connecting the lower length of intermediate shaft to the pump shaft shall be a flexible coupling of the rubber-bushed, or other approved type. The coupling between the lower length of intermediate shaft and the upper length of intermediate shaft shall be of the rigid forged, flanged type.

b. One intermediate guide bearing shall be provided for each intermediate shaft, and shall be mounted as shown on the drawings. The bearings shall be of the anti-friction type and grease lubricated. All the intermediate shafting shall be forged, open hearth steel thoroughly annealed and accurately machined to finished dimensions.

TP1-12. VALVES. - a. Hydraulically operated gate valves. (1) The gate valves to be installed in the suction and discharge lines of the 36-inch pumps shall be hydraulically operated, iron body, brass trimmed, rising stem, solid wedge type valves equal to Chapman list 35X, hydraulically operated. The valves shall be rated at 43 pounds per square inch cold water working pressure. The valves on the suction lines shall be flanged on both ends. The valves on the discharge lines shall be flanged one end and bell on the other end. All valve flanges shall be drilled in accordance with the 125-pound American Standard and all bells shall conform to the American Water Works Association Standard.

(2) The hydraulic cylinders shall be of cast iron with brass liners and shall be designed for operation using city water at a minimum pressure of 75 pounds per square inch and shall have an inside diameter of 16 inches. The inner surfaces of the cylinders shall be ground and polished after machining. Each cylinder shall be shop tested and found tight at a hydrostatic pressure of 200 pounds per square inch.

(3) Since there is not sufficient head room to permit the use of telltale rods through the tops of the cylinders, an indicating rod attached to the gate disc and extending through a stuffing box in the bonnet shall be provided for the purpose of indicating the position of the disc.

b. Hand operated gate valves. - (1) The gate valves for the 16-inch pump shall be Crane No. 496, Chapman No. 35, or equal, iron body brass trimmed, rising stem solid wedge type gate valves. The discharge valve shall be connected by a suitable extension stem to a floorstand located on the engine room floor. The valves shall be rated at 43 pounds per square inch cold water working pressure. By-passes will not be required. The valve shall be flanged, with flanges drilled in accordance with the 125-pound American Standard.

(2) The floorstand for the 16-inch discharge valve shall be a rising stem floorstand similar and equal to the Chapman Type BR.

c. Check valves. - Check valves shall be "Chapman" List 23 or equal, tilting disc, non-slam check valves suitable for 43-pounds

per square inch cold water working pressure. The body and disc shall be fitted with bronze seat rings. Hinge pins and hinge pin bushings shall be of a corrosion resisting alloy. The body shall have smooth flow lines without recesses and the net area of the waterway through the check valve shall not be less than the net area of the pipe line in which it is installed. The 16-inch check valve shall be flanged both ends. The 36-inch check valves shall be flanged on the inlet end and provided with a spigot on the discharge end. All valve flanges shall be drilled in accordance with the 125-pound American Standard and all spigots shall conform to the American Water Works Standard.

TP1-13. INLET AND DISCHARGE PIPING. - The inlet and discharge piping shall be Class "A" American Water Works Standard cast iron flanged pipe as shown on the drawings with flanges drilled to 125-pound American Standard. The design of the intake and discharge wall castings shall be subject to the approval of the Contracting Officer. Three 36-inch wall castings and two 16-inch wall castings are already in place. The Contractor shall furnish three 36-inch wall castings under this contract. All flanged connections shall be provided with full-face Garlock fibreoid gaskets or equal. The flanged connections shall be bolted together with American standard machine bolts having square heads and hexagon nuts. A drain shall be provided in the suction line. The flexible couplings shall be Dresser Style 38 steel couplings or equal and shall have the pipe stop removed.

TP1-14. ACCESSORIES. - There shall be furnished two complete sets of all necessary special wrenches and tools mounted in approved metal cases, suitable for wall mounting, one for the three 36-inch pumps and one for the 16-inch pump.

TP1-15. SHOP TESTS. - a. Each pump shall be subjected to and successfully pass in the shops of the manufacturer, hydrostatic pressure and actual running tests. All shop tests will be witnessed by the Contracting Officer or his authorized representative. The Contractor shall give written notice to the Contracting Officer at least five days prior to the date on which any pumping unit will be ready for test.

b. The hydrostatic test pressure shall be not less than two and one-half times the shut-off head of the pump, as shown by the characteristic curve. The running tests shall be made with the unit driven by the manufacturer's test motor.

c. The tests shall be conducted in accordance with the test code of the Hydraulic Institute, and shall show, before acceptance of the units, that the pumps have characteristics of head, capacity and efficiency as shown by the approved characteristic curve submitted by the Contractor. Six certified copies of the test log sheet and test curves shall be furnished the Contracting Officer.

TP1-16. FIELD TESTS. - After installation, all pumps will be operated and tested for a sufficient period of time to demonstrate that the equipment is in satisfactory operating condition and that they meet the requirements of these specifications. The tests will be made to demonstrate proper balance and mechanical performance and will be made at whatever pumping heads are available. Any altera-

tions necessary to bring the pumps, gasoline engines, diesel engine, right-angle gear units, inlet and discharge piping, or valves, up to the requirements of the specifications shall be made by the Contractor at no additional expense to the Government.

TP1-17. PAINTING. - a. General. - (1) All items of equipment shall be painted in the shop in the most thorough manner to prevent corrosion. Surfaces of metal parts to be painted shall be entirely cleaned of all scale, rust, dirt, oil or other foreign substances, by the use of scrapers, wire brushes, sand blasting, mineral spirits or other approved cleaning agents, not less than 30 minutes nor more than 5 hours prior to the application of any paint. All surfaces shall be warm and dry before applying any paint. All painting shall be done either by brush or spray, in a neat, thorough and workmanlike manner. Priming shall be done in accordance with the manufacturer's standard practice and shall be subject to the approval of the Contracting Officer.

(2) All finished surfaces not to be painted, but exposed to the atmosphere during shipment or storage, shall be coated with a heavy rust preventive compound.

b. Pumps, piping and valves. - After cleaning and priming, the pumps, piping and valves shall be given two shop coats of machinery enamel similar and equal to Kem Lustral Dado Gray-205 as manufactured by the Sherwin Williams Company.

PART IV

SECTION II. GASOLINE ENGINES (Item 3)

TP2-1. WORK INCLUDED. - The Contractor shall furnish in accordance with the drawings and specifications three gasoline engines suitable for driving the 36-inch pumps through right angle gear reduction units. The engines shall be furnished complete with silencers, exhaust piping, connections to exhaust, water and fuel lines, and flexible couplings to the gear reduction units.

TP2-2. GENERAL DESCRIPTION. - a. Each engine shall be a four-cycle internal-combustion, heavy-duty, stationary type having not less than 6 cylinders in line. Each engine shall be of late design and a current model, standard with the manufacturer and shall be the product of a reliable manufacturer who can show at least 5 years of experience in the manufacture of engines of the type specified and for similar duty.

b. Each engine shall be equipped with two starting motors and storage battery for self-starting, battery charging generator and all incidental ignition equipment, miscellaneous wrenches for special nuts, a suitable detachable hand crank, and complete operating equipment.

TP2-3. DESIGN. - a. Each engine shall operate at a governed speed not exceeding 1200 r.p.m. when driving the pump at its rated speed as defined in Paragraph TP1-4 c. At this speed the rating of the engine shall be such that when driving the gear unit and pump at any head from 0 to 30 feet, the horsepower required shall not be more than 80 percent of that which the engine is capable of delivering with auxiliaries attached and with fuel as specified in Paragraph TP2-8 a (3), as shown by published test curves for the engine which the Contractor proposes to furnish. Also when driving the gear unit and pump at any head from 30 to 38 feet, the horsepower shown on the above curve shall not be exceeded.

b. The design of the engine shall be such that, when delivering its maximum horsepower at governed speed, the stresses set up in the several parts shall not exceed safe working stresses for the material used, and shall conform to the best modern practice in the design of high-grade machinery. The design shall insure that no torsional critical speed exists within the operating speed range.

c. The detailed design of the engines shall be such that all working parts shall be readily accessible for inspection and repair, easily duplicated, and readily replaced with each part of the equipment properly designed and suitable for the use and service required.

TP2-4. CONSTRUCTION DETAILS. - a. The principal parts of the engine shall be as follows:

(1) The crankcase shall be of the pedestal base type with large removable side plates.

(2) The cylinder block shall be separate from the crankcase and shall be cast in one piece or in pairs of cylinders. Cylinders and cylinder heads shall be fully water jacketed.

(3) The crankshaft shall be made of one piece, heat-treated alloy steel forging substantially designed to withstand severe operating conditions. It shall be dynamically and statically balanced and all journals shall be ground and polished. The crank shaft shall be drilled for pressure feed lubrication.

(4) The camshaft shall be of forged alloy heat-treated steel, with integral cams. The cam faces and bearing surfaces shall be carburized, hardened and ground finished to size.

(5) The connecting rods shall be of high-grade forged alloy-steel, properly heat-treated.

(6) Pistons shall be of light-weight cast iron, or alloy, and of such construction as to provide uniform expansion of piston skirt. Each piston shall be equipped with at least four rings, three above the piston pin and one below. The piston pin shall be of tubular hardened steel, accurately ground and securely locked in place.

(7) Push rods shall be of hardened steel and accurately ground. The push rod guides shall be bronze and of the removable type.

(8) The flexible coupling shall be of an approved flexible metallic type and shall be provided with a suitable guard. The coupling shall be suitable for transmitting 300 per cent of the normal operating torque of the engine, and shall be similar and equal to Waldron cut-out type with disengaging lever.

(9) The main bearings shall be bronze-backed, babbitt-lined, of a readily removable sleeve type, and shall be accurately fitted and anchored against side thrust. Oil, under pressure, shall be suitably admitted to the inside of each main bearing shell.

(10) The flywheel shall be of gray iron or steel, statically and dynamically balanced. It shall be securely attached to the crankshaft ahead of the flexible coupling.

(11) The valves shall be of special heat resisting steel, of large area, accurately fitted and ground to fit the valve seats. The valve seats shall be removable and of special steel, heat-treated.

(12) A positive displacement gear driven pump shall supply oil under pressure to all bearings, valve operating mechanism, piston pins, and timing gears. The pump shall be accessible and removable without dismantling the engine. An oil pressure gauge shall be installed on the control board. (See Paragraph TP2-5.) A hand pump

of the gear type shall be provided to force oil through the system prior to starting engine. A suitable, high grade oil filter with safety by-pass valves shall be provided and installed on the engine.

(13) The carburetors shall be of the heavy duty type, equipped with chokes, gasoline filters, air filters, drip pans, and flame arresters. Each engine shall be equipped with two engine-driven diaphragm type pumps for supplying gasoline to the carburetors. Also each engine shall be provided with a hand-operated fuel pump equipped with a spring loaded by-pass valve set to unload at 4 pounds per square inch. Connections to the gasoline lines shall be made with flexible seamless bronze hose with woven wire protection and packless couplings. A brass gate valve shall be installed in the gasoline feed line to each carburetor. Air leakage around the pivot of the butterfly valve shall be eliminated to provide good mixture control. The storage tanks and piping will be furnished and installed by others. The carburetors and piping shall conform to the requirements of the Underwriters Laboratories.

(14) Ignition and starting system. - (a) A 12-volt battery-type dual ignition system shall be provided, with two independently driven distributors, two heavy-duty ignition coils, and two spark plugs in each cylinder, fired simultaneously. The starter push button switch of each engine shall consist of two single-pole contacts in tandem so arranged that the battery charging circuit is opened before the engine cranking circuit is closed. The switch shall be spring operated and shall close the battery charging contacts in its normal position. A terminal block ^{in an enclosed box} shall be installed on the engine to provide for connecting the battery charger on the station switchboard.

(b) Two 12-volt, heavy-duty electric cranking motors shall be provided for starting each engine. Each cranking motor shall be controlled by a 12-volt magnetic switch, the two switches being actuated by a push-button switch on the engine panelboard. The cranking motors shall be capable of cranking the engine at sufficient speed to insure starting when the engine is connected to the pump through the gear-reduction unit, with the pump casing full of water, and with a 32-degree F. ambient engine-room temperature (see subparagraph (c) below). Suitable provision shall be made to prevent operation of the engine cranking motors except when the spark control lever is in full retard position.

(c) A 12-volt storage battery shall be provided for each engine. The battery shall have sufficient capacity to provide a 3-minute continuous cranking of complete unit at firing speed under operating conditions with an ambient engine-room temperature, lubricating oil temperature and battery temperature of 32 degrees Fahrenheit and with the engine direct-connected to the pump with its casing full of water.

The battery shall have special plate construction for severe or unusual conditions. Each positive plate shall be composed of multiple insulated containers filled with active materials, the containers to run vertically, horizontally or diagonally, permitting free passage of electrolyte from one face of the plate to the other; each container shall

be slotted or perforated to permit diffusion of the acid electrolyte into the containers.

The electrolyte shall be of the low-gravity type with a specific gravity of 1.200 to 1.220.

The battery shall conform to the specifications for United States Government award by the Treasury Department, Procurement Division, Branch of Supply for lead-acid storage batteries, Class 17, Item B8630.

A suitable shelf or platform with an acid-proof rubber or lead tray shall be provided on or located adjacent to the engine base for mounting the battery.

(15) Governor. - (a) A governor shall be mounted directly on the engine and arranged for force-feed lubrication. It shall be of the non-hunting, precision type, capable of maintaining the engine speed within 5 percent of rated speed during part-load changes from full-load to no-load, and shall be fitted with a device for manual resetting to any desired speed regardless of wide open throttle position.

(b) The engine shall be provided with an automatic ignition cut-out switch that will shut the engine down when the engine speed exceeds that normally controlled by the governor. The cut-out switch shall be adjustable and provided with manual reset.

(16) The exhaust manifold shall be a close-grained gray iron casting, water jacketed for its entire length and provided with suitable flange connections having straight pipe thread for exhaust pipe. A water-cooled brass or bronze flexible exhaust shall be provided as shown on the drawings and shall be similar and equal to that manufactured by the Packless Metal Products Corporation of Long Island City, New York.

(17) An exhaust silencer for each engine shall be provided for mounting on the roof as shown on the drawings. The silencer shall be of corrosion resistant metal and shall be similar and equal to the Model MU-2 manufactured by the Maxim Silencer Company, or the equivalent silencer manufactured by the Burgess Battery Company. The expansion joint shall be similar and equal to the internally guided expansion joint as manufactured by the American District Steam Co., North Tonawanda, N. Y.

(18) The cooling system for the engines shall be the open type with water obtained from the city water system. A temperature-regulated valve shall be installed in the cooling water intake to regulate the flow of cooling water through the engine. The regulator shall be equal to that manufactured by the Fulton Sylphon Company. A suitable gate valve shall be installed in the line ahead of the regulator. There shall be provided a pressure temperature operated switch so arranged that it will open the ignition circuit in the event the oil pressure is not adequate for safe operation of the engine or in the event the cooling water temperature exceeds that at which the switch is set to operate. A foot-operated switch shall be provided for use when the engine is being started to cut-out the oil pressure safety switch.

b. Other details of the engines not specifically mentioned shall conform to the requirements of approved standard practice applying to the part and service intended.

TP2-5. MISCELLANEOUS EQUIPMENT. - a. Instrument panel. - A polished metal panelboard shall be installed on each engine and the following instruments and equipment mounted thereon:

- 1 - tachometer
- 1 - main oil line pressure gauge
- 1 - temperature gauge
- 1 - ammeter
- 1 - cranking motor-push-button switch
- 2 - ignition switches

b. Tools. - One set of special wrenches or tools shall be provided and mounted in a cabinet, suitable for wall mounting.

TP2-6. DRAWINGS. - The Contractor shall furnish drawings and specifications for the proposed engines for approval. The drawings shall give all principal dimensions of the engine and all accessories. Accessories shall be listed on the drawings by catalog number with name of manufacturer, and shall be accompanied by cuts and the manufacturer's specifications for the accessories, all properly numbered to agree with the list as shown on the drawings.

TP2-7. SHOP ASSEMBLY. - All work shall be neatly and accurately done and shall be in accordance with the highest standards of practice for equipment of the type to be furnished. The engine shall be accurately aligned on the bed-plate and securely attached thereto. Provision shall be made for lifting the engine by a crane.

TP2-8. INSPECTION AND TESTS. - a. Each engine unit will be inspected and tested in the shop by an authorized representative of the Contracting Officer. Four typewritten records of the tests, including calculations, results, and graphs, shall be submitted to the Contracting Officer by the manufacturer, together with a sworn statement from the person supervising the tests. The engine shall be tested for satisfactory operation under the following conditions:

(1) The engine shall be run continuously at a governed speed corresponding to the rated speed of the pump for 22 hours under a sustained load equal to the continuous horsepower rating required by Paragraph TP2-3 a. followed by a two-hour run at the maximum horsepower output of the engine. This test shall be continuous for a total of 24 hours.

(2) The valve setting and governor control shall be checked by means of a tachograph, with the entire unit operating under various loading conditions ranging from no-load to the maximum load of the pump rating.

(3) All tests shall be made using commercial standard gasoline fuel conforming to Federal Specification VV-G-101a and having an octane rating of 65 - 70.

(4) Immediately after running tests for the engine, the Contracting Officer or his representative will require that the engine be opened for inspection.

b. Field tests and trails shall be made after installation under the supervision of and as directed by the Contracting Officer. They shall be of sufficient loading and duration to demonstrate to the satisfaction of the Contracting Officer that the complete unit as installed is in conformity with the specifications. Any alterations necessary to bring the engines up to the requirements of the specifications shall be made by and at the expense of the Contractor.

c. The cost of all testing shall be borne by the Contractor, except for the Government's representatives, and fuels and lubricants used during field tests, and shall be included in the contract price for the item.

TP2-9. PAINING. - The provisions of Paragraph TP1-17 a shall apply. After cleaning and priming, the engines shall be given two coats of machinery enamel similar and equal to Kem-Lustral "Dado Gray-205" as manufactured by the Sherwin Williams Company.

PART IV

SECTION III. RIGHT ANGLE GEAR UNITS (Items 4 and 5)

TP3-1. WORK INCLUDED. - Under Item 4, the Contractor shall furnish three right-angle gear units for continuous transmission of the power from the horizontal gasoline engines to the vertical pump shafts of the 36-inch pumps. Under Item 5, the Contractor shall furnish one right-angle gear unit for continuous transmission of the power from the horizontal diesel engine to the vertical pump shaft of the 16-inch pump. Each unit shall be ready for connection to its respective engine and pump.

TP3-2. TYPE AND RATING. - Each gear unit shall be the self-contained type designed for transmitting power from the horizontal engine shaft through spiral bevel gears to the vertical pump shaft. The horsepower rating shall be in accordance with the recommended practice of the American Gear Manufacturers' Association. The gear units shall have a service factor of not less than 1.25 times the power required to drive the pumps under any head from zero to 30 feet. Each gear unit shall be a standard unit that is regularly manufactured for service similar to that required by these specifications.

TP3-3. HOUSING. - The housing of the gear unit shall be of rigid, compact design, with a base made of close-grained cast iron. The cover of the housing shall be of close-grained cast iron, or fabricated steel plate. The design of the housing shall be such that all bearings are supported in the base section, and the cover may be removed without disturbing the bearings, gears, or oil piping. All joints shall be machine-finished, oil-tight, and dust-proof. Suitable cover-plates shall be provided that will permit easy access to the interior for examination and adjustment of the parts. Eye bolts shall be provided for lifting the unit. The anchor bolt holes shall be drilled all on the same bolt circle and equally spaced.

TP3-4. GEARS. - The spiral bevel gears shall be of the precision generated, curved-tooth type, made of alloy steel and heat-treated and lapped. The gears shall be designed to give the proper ratio and transmit the power without undue strain. Gears and pinions shall be adequately supported between bearings, and so mounted that they will be in precise alignment at all times.

TP3-5. SHAFTS. - The shafts shall be made of forged, heat-treated steel and shall be of ample size to provide against deflection. The shafts shall be supported in anti-friction bearings of the radial thrust type, widely spaced. A thrust bearing of the ball or roller bearing type shall be incorporated which will support the weight of the rotating parts. The bearings shall be of ample size and rating for the duty required of them. Provision shall be made to provide vertical adjustment for the pump shaft (see Paragraph TP1-8). The slow speed vertical shaft shall be of hollow shaft design connected at the top through a clamp coupling to the vertical pump shaft. The coupling shall be provided with suitable shear pins designed to allow engine and gears to run free in case the pump should clog. Two spare sets of shear pins shall be furnished with each gear unit.

TP3-6. LUBRICATION. - A lubricating system shall be furnished providing a continuous flow of oil to all bearings, and spray lubrication at point of engagement of the gears. The lubrication system shall be capable of supplying sufficient oil to lubricate all parts when the unit is running at a speed corresponding to approximately one-half of the rated speed of the engine. The oil system including all oil piping shall be self-contained within the gear unit, with adequate oil supply carried in the base of the gear housing. Suitable oil piping shall be provided to drain the oil from the housing. The circulating oil pump shall be self-priming, of the positive flow type, capable of delivering a sufficient quantity of oil when the unit is running at one-half its normal rated speed. An oil level indicator, oil strainer, oil flow indicator, and an oil pressure gage of approved design shall be provided. Oil piping shall be of brass with sufficient unions inserted in the lines so that the piping can be readily dismantled. The unit shall be self-cooling without the use of cooling water and when operating continuously under rated load the temperature of the lubricating oil shall not exceed 160 degrees F. at an ambient air temperature of 70 degrees F. Oil seals shall be provided at the shaft outlet but no stuffing box or glands shall be used.

TP3-7. INSPECTION AND TESTS. - a. Each gear unit will be inspected and tested in the shop by an authorized representative of the Contracting Officer. Four typewritten copies of the record of the tests, including observations, calculations, results and graphs shall be submitted to the Contracting Officer by the manufacturer, together with a sworn statement from the person supervising the tests. The gear units shall be tested for satisfactory operation under the following conditions:

(1) Each gear unit housing shall be filled with kerosene and tested under 20 pounds pressure to determine that the castings are tight and do not leak oil. Leaky castings will not be accepted.

(2) The gear units shall be driven continuously for eight hours at full load and speed. The test load shall be equal to the maximum horsepower required by the pump under any condition of head between 0 and 30 feet.

(3) After installation, each unit will be operated and tested for a sufficient period of time to demonstrate that it is in satisfactory operating condition and meets the requirements of these specifications. Any alterations necessary to bring the gear units up to the requirements of the specifications shall be made by the Contractor at no additional expense to the Government.

b. The cost of all testing shall be borne by the Contractor, except for the Government's representative, and shall be included in the contract price for the item.

TP3-8. PAINTING. - The provisions of Paragraph TP1-17 a shall apply. After cleaning and priming, the gear units shall be given two coats of machinery enamel similar and equal to Kem-Lustral "Dado-Gray - 205" as manufactured by the Sherwin-Williams Company.

PART IV

SECTION IV. DIESEL ENGINE (Item 6)

TP4-1. WORK INCLUDED. - The Contractor shall furnish according to the drawings and specifications, one diesel engine to drive the 16-inch pump. The engine shall be furnished complete with silencer, exhaust lines, connections to water, fuel and exhaust lines, and flexible coupling to the gear reduction unit.

TP4-2. GENERAL DESCRIPTION. - The engine shall be a solid injection, full diesel engine having not less than four cylinders in line. The engine shall be of late design and a current model, standard with the manufacturer, and shall be the product of a reliable manufacturer who can show at least 5 years of experience in the manufacture of engines of the type specified and for similar duty. The engine shall be similar and equal to the General Motors' Series 71.

TP4-3. RATING - DESIGN. - The engine shall operate at a governed speed not exceeding 1200 R.P.M. when driving the pump at its rated speed as defined in Paragraph TP1-4. At this speed the rating of the engine shall be such that, when driving the gear unit and pump at any head from 0 to 30 feet, the horsepower required shall not be more than 70 per cent of that which the engine is capable of delivering with all auxiliaries attached and with fuel as specified in Paragraph TP4-7.

TP4-4. DETAILED CONSTRUCTION. - The principal parts of the engine shall be as follows. Details not specifically mentioned shall conform to the requirements of standard practice applying to the parts and the service intended.

a. The cylinder block shall be cast in one piece of alloy iron. Airtight inspection plates shall be provided for easy access to the parts for inspection and cleaning.

b. The cylinder head shall be cast in one piece of the same material as the cylinder block. The head shall be machined to accurate dimensions to insure proper clearance volume and to give proper balance of pressures between all the cylinders. The cylinder head shall be designed to carry the fuel spray nozzles and exhaust valves.

c. The cylinder liners shall be of the removable, dry type constructed of alloy steel ground and honed to a smooth surface on the inside. The angularity of the intake ports shall be such as to impart a rotational motion to the entering air.

d. A scavenging blower shall be mounted on the cylinder block, securely bolted and doweled and shall be removable for inspection and repair. The blower rotors shall be of the three-lobe helical type pressed and pinned on steel shafts, the ends of which shall be seated in removable steel babbit bearings. The rotors shall be driven by a pair of helical timing gears accurately machined and doweled to insure

proper clearances between the rotors. Rotors, bearings, and gears shall be encased in an airtight aluminum housing well ribbed for strength and rigidity. All bearings shall be designed for force feed lubrication. A lubricating oil overflow to the crankcase shall be provided. The blower shall be furnished with an air cleaner and silencer for the intake air.

e. The crankshaft shall be made in one piece and shall be a heat-treated alloy steel forging, designed to withstand the peak pressure of combustion. It shall be statically and dynamically balanced. The crankshaft shall be drilled for pressure feed lubrication.

f. The camshaft shall be of forged alloy heat treated steel with integral cams. The cam faces and bearing surfaces shall be carburized, hardened and polished to size.

g. The pistons shall be of light weight cast iron or alloy and of such construction as to provide uniform expansion of the piston skirt. Each piston shall be equipped with four compression rings above the wrist pin and two oil rings below.

h. The flywheel shall be of gray iron or steel and shall be statically and dynamically balanced. It shall be securely attached to the crankshaft ahead of the flexible coupling.

i. The flexible coupling shall be of an approved, flexible, metallic type and shall be provided with a suitable guard. The coupling shall be suitable for transmitting 300 per cent of the normal operating torque of the engine and shall be similar and equal to the Waldron Cut-Out Type Coupling as manufactured by the John Waldron Corporation, New Brunswick, N. J.

j. The main bearings shall be of the removable type and shall be one more than the number of cylinders. They shall be steel backed, diesel babbitt or lead-bronze-lined. The main and connecting rod bearings shall be drilled for pressure feed lubrication.

k. Lubrication. - A positive displacement gear driven pump shall supply oil under pressure to all bearings, valve operating mechanism, piston pins and timing gears. A suitable high grade oil filter with safety bypass valves and an oil cooler shall be provided and installed on the engine. Specially prepared lubricating oils shall not be required.

l. The fuel injection system shall be of the solid injection type using unit injectors combining a pump and a spray nozzle for each cylinder. Metering of the fuel shall be accomplished by varying the effective stroke of the fuel pump plunger in accordance with the demand of the governor transmitted through a servo cylinder valve to the injector rack assembly. The connection to the fuel line shall be made with flexible seamless bronze hose with woven wire protection.

m. The governor shall be of the flyball type, fully enclosed, self-lubricating, and arranged with manual control for constant speed operation at any speed from full speed down to 50 per cent of full rated speed and so arranged that the speed of the engine can be controlled

within this range of limits without stopping the engine. The governor shall maintain 5 per cent speed regulation from full load to no load.

n. The exhaust system shall be designed to prevent back pressure and to reduce exhaust noise to a minimum. Exhaust gases shall be swept from the cylinder by scavenging air admitted through fixed ports in the cylinder liners. Scavenging air shall be precompressed to not less than 5 pounds per square inch. The exhaust manifold shall be close-grained cast iron provided with suitable flange connections having straight pipe thread for the exhaust pipe. A flexible, water-cooled, bronze exhaust connection shall be provided as shown on the drawings, and shall be similar and equal to that manufactured by the Packless Metal Products of Long Island City, New York.

o. The exhaust silencer for the engine shall be similar and equal to the Maxim model MU-2 as manufactured by the Maxim Silencer Co., Hartford, Conn. and shall be made of corrosion-resisting metal.

p. The cooling system for the engine shall be of the open type with water obtained from the city water system. A temperature regulating valve shall be installed in the cooling water intake to regulate the flow of cooling water through the engine. The regulator shall be similar and equal to that manufactured by the Fulton Sylphon Co. A suitable gate valve shall be installed in the line ahead of the regulator. There shall be furnished a safety device of approved type arranged to automatically stop the engine in case of failure of the lubricating system or in case of excessive temperature of the cooling water. Provision shall be made to cut out the oil pressure safety device when starting the engine. The temperature of the cooling water as it leaves the engine shall not exceed 190 degrees F. and shall be not less than 175 degrees F.

q. The starting system shall consist of a 12-volt storage battery and one 12-volt heavy duty electric cranking motor operated by a push-button switch located on the instrument panel. A terminal block shall be installed on the engine to provide for connecting the battery charging leads from the battery charger on the pumping station switchboard. The starting push-button switch shall consist of two single-pole contacts in tandem so arranged that the battery charging circuit is opened before the engine cranking circuit is closed. The switch shall be spring operated and shall close the battery charging contacts in its normal position.

(1) The electric cranking motor shall be of the 12-volt, heavy-duty type controlled by a 12-volt magnetic switch operated by the starting push-button switch on the instrument panel. The cranking motor shall be capable of cranking the engine at sufficient speed to insure starting with the engine connected to the pump through the gear-reduction unit, with the pump-casing full of water, and with a 32-degree Fahrenheit ambient engine-room temperature.

(2) The storage battery shall have sufficient capacity to provide a 3-minute continuous cranking of the complete unit at firing speed under the conditions stated in subparagraph q (1) above.

(a) The battery shall have special plate construction for severe and unusual conditions. Each positive plate shall be composed of multiple insulated containers filled with active materials, the containers to run vertically, horizontally, or diagonally, permitting free passage of electrolyte from one face of the plate to the other, each container shall be slotted or perforated to permit diffusion of the acid electrolyte into the containers.

(b) The electrolyte shall be of the low-gravity type with a specific gravity of 1.200 to 1.220.

(c) The battery shall conform to the specifications for the United States Government award by the Treasury Department, Procurement Division, Branch of Supply for lead-acid storage batteries, Class 17, Item B8630.

(d) A suitable shelf or platform with an acid-proof rubber or lead tray shall be provided on or located adjacent to the engine base for mounting the battery.

TP4-5. MISCELLANEOUS EQUIPMENT. - a. Instrument panel. - A polished metal instrument panel shall be installed on each engine with the following instruments and equipment mounted thereon:

- 1 - tachometer (accurate within limits of 2 per cent)
- 1 - main oil line pressure gauge
- 1 - ammeter
- 1 - cranking motor push button switch
- 1 - temperature gauge - cooling water
- 1 - temperature gauge - engine exhaust

b. Tools. - A complete set of special wrenches or tools shall be provided for servicing all parts of the engine and shall be mounted in a cabinet, suitable for wall mounting.

TP4-6. DRAWINGS. - The Contractor shall furnish drawings and specifications for the proposed engine for approval. The drawings shall give all principal dimensions of the engine and all accessories. Accessories shall be listed on the drawings by catalogue number with name of manufacturer, and shall be accompanied by cuts and the manufacturer's specification for the accessories, all properly numbered to agree with the list as shown on the drawings.

TP4-7. INSPECTION AND TESTS. - a. The engine will be inspected and tested in the shop by an authorized representative of the Contracting Officer. Four typewritten copies of the record of the tests, including observations, calculations, results and graphs shall be submitted to the Contracting Officer by the manufacturer, together with a sworn statement from the person supervising the tests. The engine shall be tested for satisfactory operation under the following conditions:

(1) The engine shall be run continuously at a governed speed corresponding to rated speed of the pump for 12 hours under a sustained load equal to the continuous horsepower rating required by Para-

graph TP4-3 followed by a two-hour run at the maximum horsepower output of the engine. This test shall be continuous for a total of 14 hours.

(2) The Governor shall be checked by means of a tachograph with the entire unit operating under various loading conditions ranging from no load to maximum load of the pump rating.

(3) All tests shall be made using Diesel fuel oil conforming to A.S.T.M. Designation 1 D having an Octane Number rating of 50 min. and a Diesel number of 45 min.

(4) Exhaust temperatures shall be checked by means of a pyrometer while operating under the load conditions given in Paragraph TP1-4 b. Temperatures shall be taken after not less than one hour of continuous running under both conditions.

(5) Compression pressures shall be checked by means of an indicator before and after running tests; any wide variation in compression pressures shall be rectified and running test shall be re-run according to subparagraph (1) above.

(6) Immediately after running tests for the engine, the Contracting Officer or his representative will require the engine to be opened for inspection.

b. Field tests and trials shall be made after installation under the supervision of and as directed by the Contracting Officer. Any alterations necessary to bring the engines up to the requirements of the specifications shall be made by the Contractor at no additional expense to the Government.

c. The cost of all testing shall be borne by the Contractor, except for the Government's representatives, and fuels and lubricants used during field tests, and shall be included in the contract price for the item.

TP4-8. PAINTING. - The provisions of Paragraph TP1-17 a shall apply. After cleaning and priming, the engine shall be given two coats of machinery enamel, similar and equal to Kem-Lustral "Dado Gray-205" as manufactured by the Sherwin-Williams Company.